Electronic Version
Stylesheet Version v1.1.1

Claims

[c1] What is claimed is:

1. A method for patterning an HfO2-containing gate dielectric, the method comprising:
providing a wafer having a trench, a STI layer formed in the trench, the HfO2-containing gate dielectric covering the wafer and the STI layer, a gate electrode formed on the HfO2-containing gate dielectric, and at least a spacer formed beside the gate electrode;
preheating the wafer; and
providing a bromine-rich gas plasma to remove portions of the HfO2-containing gate dielectric.

[c2] 2. The method of claim 1 wherein the method comprises utilizing a lamp tray heater to preheat the wafer.

[c3] 3. The method of claim 1 wherein the method comprises utilizing a non-reactive gas plasma to preheat the wafer.

[c4] 4. The method of claim 1 wherein the bromine-rich gas plasma comprises a Br2 plasma, a HBr plasma, or a mixture of a Br2 plasma and a HBr plasma.

[c5] 5. The method of claim 1 wherein concentration of the bromine-rich gas plasma is higher than 30%.

[c6] 6. The method of claim 1 wherein the wafer is preheated to a controlled temperature of higher than 200°C.

[c7] 7. The method of claim 1 wherein the STI layer comprises SiO2.

[c8] 8. The method of claim 1 wherein the spacer comprises SiO2.

[c9] 9. The method of claim 1 wherein the gate electrode comprises TaN or TiN.

[c10] 10. The method of claim 1 wherein the wafer further has a sacrifice layer formed on the gate electrode.

[c11] 11. The method of claim 10 wherein the sacrifice layer comprises SiO2.

[c12] 12. A method for etching an HfO2-containing dielectric, the method comprising:
providing a wafer having the HfO2-containing dielectric;
preheating the wafer; and
providing a bromine-rich gas plasma to remove portions of the HfO2-containing dielectric.

[c13] 13. The method of claim 12 wherein the method comprises utilizing a lamp tray heater to preheat the wafer.

[c14] 14. The method of claim 12 wherein the method com-

prises utilizing a non-reactive gas plasma to preheat the wafer.

[c15] 15. The method of claim 12 wherein the bromine-rich gas plasma comprises a Br2 plasma, a HBr plasma, or a mixture of a Br2 plasma and a HBr plasma.

[c16] 16. The method of claim 12 wherein concentration of the bromine-rich gas plasma is higher than 30%.

[c17] 17. The method of claim 12 wherein the wafer is pre-heated to a controlled temperature of higher than 200°C.

[c18] 18. A method for patterning an HfO2-containing gate dielectric, the method comprising:
providing a wafer having a trench, a STI layer formed in the trench, the HfO2-containing gate dielectric covering the wafer and the STI layer, a gate electrode formed on the HfO2-containing gate dielectric, and at least a spacer formed beside the gate electrode;
performing a nitrogen ion bombardment to convert the exposed HfO2-containing gate dielectric to an Hf3N4 layer; and
utilizing a phosphoric acid to remove the Hf3N4 layer.

[c19] 19. The method of claim 18 wherein the STI layer comprises SiO2.

[c20] 20. The method of claim 18 wherein the spacer comprises SiO2.

[c21] 21. The method of claim 18 wherein the gate electrode comprises TaN or TiN.

[c22] 22. The method of claim 18 wherein the method comprises utilizing a nitrogen gas or a nitrogen-contained gas to perform the nitrogen ion bombardment.

[c23] 23. The method of claim 18 wherein the phosphoric acid comprises a H3PO4 solution.

[c24] 24. The method of claim 18 wherein the Hf3N4 layer is removed at temperature between 50°C and 300°C.

[c25] 25. A method for etching an HfO2-containing dielectric, the method comprising:
providing a wafer having the HfO2-containing dielectric;
performing a nitrogen ion bombardment to convert portions of the HfO2-containing dielectric to an Hf3N4 layer; and
utilizing a phosphoric acid to remove the Hf3N4 layer.

[c26] 26. The method of claim 25 wherein the method comprises utilizing a nitrogen gas or a nitrogen-contained gas to perform the nitrogen ion bombardment.

[c27] 27. The method of claim 25 wherein the phosphoric acid

comprises a H3PO4 solution.

[c28] 28. The method of claim 25 wherein the Hf3N4 layer is removed at temperature between 50°C and 300°C.